IN THE CLAIMS

1-32. (Canceled)

33. (Currently Amended) A photo-detector ~~with a reduced G-R noise,~~ comprising a heterostructure ~~sequence of~~ comprising a first heterojunction, formed by an n-type photon absorbing material ~~a p-type contact~~ layer of a certain energy bandgap~~,~~ and an n-type middle barrier layer, and a second heterojunction, formed by said n-type middle barrier layer and a p-type contact layer, the layer materials being selected such that the energy bandgap of the ~~and an n-type~~ photon absorbing layer is narrower than that of~~,~~ said middle barrier layer ~~having an energy bandgap significantly larger than that of the photon absorbing layer and having n-type doping, there being no layer with a narrower energy bandgap than that in the photon absorbing layer~~, the first and second heterojunctions being thus configured and operable to prevent creation of a depletion region in said photon absorbing layer when a bias voltage is applied across the heterostructure such that a tunnel current of electrons from the contact layer to the photon absorbing layer is less than a dark current in the photo-detector and the dark current from the photon-absorbing layer to the barrier layer is essentially diffusion limited, thus reducing generation recombination (GR) noise of the photo-detector~~wherein under flat band conditionsthe valence band edge of the contact layer lies below its own conduction band edge, or below the conduction band edge of the barrier layer, by significantly more than the bandgap energy of the photon absorbing layer and, wherein when biased with an externally applied voltage, the bands in the photon absorbing layer next to the barrier layer are flat or accumulated, and the flat part of the valence band edge of the photon absorbing layer lies below the flat part of the valence band edge of the contact layer and it also lies an energy of not more than~~ ~~$10kT_{op}$~~

~~above the valence band edge in any part of the barrier layer, where k is the Boltzman constant and T_{op} is the operating temperature~~.

34. (Currently Amended) A photo-detector according to claim 33 wherein said layer materials are selected such that the middle barrier layer has an energy bandgap at least twice ~~that~~ said energy bandgap of the photon absorbing layer, and wherein under flat band conditions a valence band edge of the contact layer lies below its own conduction band edge~~,~~ or below a conduction band edge of the barrier layer, by at least twice the bandgap energy of the photon absorbing layer.

35. (Currently Amended) A photo-detector according to claim 33 or 34 wherein the photon absorbing layer has a ~~typical~~ thickness of 1-10μm and doping of $n < 10^{16}$ cm^{-3}.

36. (Previously Presented) A photo-detector according to claim 33 or 34 wherein the middle barrier layer has a thickness of between 0.05 and 1μm.

37. (Currently Amended) A photo-detector according to claim 33 or 34 wherein the barrier layer is doped n-type, ~~typically~~ $n < 5 \times 10^{16}$ cm^{-3}, and a p-n junction is formed between said barrier layer and a p-type, ~~$p < 5\times10^{18}$ cm^{-3},~~ contact layer having a doping of $p < 5\times10^{18}$ cm^{-3}.

38. (Cancelled)

39. (Previously Presented) A photo-detector according to claim 33, wherein the photon absorbing layer is InSb or an $In_{1-x}Al_xSb$ alloy.

40. (Previously Presented) A photo-detector according to claim 33 wherein the contact layer is InSb or an $In_{1-x}Al_xSb$ alloy.

41. (Previously Presented) A photo-detector according to claim 33 wherein the middle barrier layer is an $In_{1-x}Al_xSb$ alloy.

42. (Previously Presented) A photo-detector according to claim 34, wherein the photon absorbing layer is an $InAs_{1-x}Sb_x$ alloy.

43. (Previously Presented) A photo-detector according to claim 34 wherein the photon absorbing layer is a type II superlattice material which comprises alternating sub-layers of $InAs_{1-w}Sb_w$ and $Ga_{1-x-y}In_xAl_ySb_{1-z}As_z$ with $0\leq w \leq 1$, $0\leq x \leq 1$, $0\leq y \leq 1$, $0\leq z \leq 1$ and $x + y < 1$ and wherein the sub-layers each have a thickness in the range of 0.6-10 nm.

44. (Previously Presented) A photo-detector according to claim 34 wherein the contact layer is GaSb.

45. (Previously Presented) A photo-detector according to claim 34, wherein the contact layer is a type II superlattice comprising alternating sub-layers of $InAs_{1-w}Sb_w$ and $Ga_{1-x-y}In_xAl_ySb_{1-z}As_z$ with $0\leq w \leq 1$, $0\leq x \leq 1$, $0\leq y \leq 1$, $0\leq z \leq 1$ and $x + y < 1$ and wherein the sub-layers have a thickness in the range of 0.6-10 nm.

46. (Previously Presented) A photo-detector according to claim 34 wherein the middle barrier layer is a $Ga_{1-x}Al_xSb_{1-y}As_y$ alloy with $0\leq x \leq 1$ and $0\leq y \leq 1$.

47. (Currently Amended) A photo-detector according to claim 33 or 34 in which the n-type photon absorbing layer is terminated by a highly n-doped terminating layer, ~~typically~~ with $3 \times 10^{17} < n < 3 \times 10^{18}$ donors cm^{-3}, and with thickness 0.5 - 4μ, so that the valence band edge of said highly n-doped terminating layer lies below that ~~of~~ in the next n-type photon absorbing layer.

48. (Previously Presented) A photo-detector comprising stacked detector sub-units as in claim 42 in which each detector sub-unit has a different cut-off wavelength and in which each detector sub-unit is separated from its neighboring sub-unit by a p-type GaSb layer to which an external contact is made.

49. (Previously Presented) A photo-detector comprising stacked detector sub-units as in claim 47 in which each detector sub-unit has a different cut-off wavelength and in which each detector sub-unit is separated from its neighboring sub-unit by a p-type GaSb layer to which an external contact is made.

50. (Currently Amended) A photo-detector ~~with a reduced G-R noise,~~ comprising a heterostructure ~~sequence of~~ comprising a first heterojunction, formed by an n-type contact material layer and~~,~~ a middle p-type-barrier layer and a second heterojunction formed by said p-type middle barrier layer and a p-type photon absorbing material layer of a certain energy bandgap, the layer materials being selected such that the energy bandgap of said ~~said middle barrier layer having an energy bandgap significantly more than and preferably at least twice that of the~~ photon absorbing layer is narrower than that of the middle barrier, ~~and having p-type doping, there being no layer with a narrower energy bandgap than that in the photon-absorbing layer,~~ the first and second heterojunctions being thus configured and operable to prevent creation of a depletion region in said photon absorbing layer when a bias voltage is applied across the heterostructure such that a tunnel current of holes from the contact layer to the photon absorbing layer is less than a dark current in the photo-detector and the dark current from the photon-absorbing layer to the barrier layer is essentially diffusion limited, thus reducing generation recombination (GR) noise of the photo-detector ~~wherein under flat band conditions the conduction band edge of the contact layer lies above its own valence band edge or above the valence band edge of the barrier layer by significantly more than and preferably at least twice the bandgap energy of the photon absorbing layer and, wherein when biased with an externally applied voltage, the bands in the photon absorbing layer next to the barrier layer are flat or accumulated, and the flat part of the conduction band edge of the photon absorbing layer lies above the flat part of the conduction band edge of the contact layer and it also lies an energy of~~

~~not more than $10kT_{op}$ below the conduction band edge in any part of the barrier layer, where k is the Boltzman constant and T_{op} is the operating temperature~~.

51. (Currently Amended) A photo-detector according to claim 50 wherein the photon absorbing layer has a ~~typical~~ thickness of 1-10μ and doping of $p < 10^{16}$ cm^{-3}.

52. (Currently Amended) A photo-detector according to claim 50 wherein the barrier layer is doped p-type, ~~typically~~ p < 5 × 10^{16} cm^{-3}, and a p-n junction is formed between said barrier layer and a n-type, n < 5×10^{18} cm^{-3}, contact layer.

53. (Cancelled)

54. (Cancelled)

55. (Currently Amended) A photo-detector according to claim 50 in which the p-type photon absorbing layer is terminated by a highly p-doped terminating layer, ~~typically~~ with 3 × 10^{17} < p < 3 × 10^{20} acceptors cm^{-3}, and with thickness 0.5 - 4μm, so that ~~the~~ a conduction band edge of the highly p-doped terminating layer lies above that in~~of~~ the next p-type photon absorbing layer.

56. (Previously Presented) A photo-detector comprising stacked detector sub-units as in claim 33, claim 34, or claim 50, in which each detector sub-unit has a different cut-off wavelength.

57. (Currently Amended) An array of ~~identical~~ detectors in which each detector is as in claim 33, claim 34 or claim 50 and is connected to a silicon readout circuit by an indium bump.

58. (Currently Amended) An array of ~~identical~~ detectors in which each detector is sensitive to more than one wavelength band as in claim 48, and in which each detector is connected to a silicon readout circuit using one indium bump or using one indium bump per detector sub-unit.

59. (Currently Amended) An array of ~~identical~~ detectors in which each detector is sensitive to more than one wavelength band as in claim 49, and in which each detector is connected to a silicon readout circuit using one indium bump or using one indium bump per detector sub-unit.

60. (Currently Amended) An array of ~~identical~~ detectors in which each detector is sensitive to more than one wavelength band as in claim 56, and in which each detector is connected to a silicon readout circuit using one indium bump or using one indium bump per detector sub-unit.

61. (Previously Presented) A photo-detector according to claim 33, wherein one or more mesa structures are etched through the uppermost layer to a depth suitable for electrical isolation.

62. (Previously Presented) A photo-detector according to claim 61 in which the surfaces of each mesa structure exposed by the etch treatment undergo a chemical treatment after which a dielectric layer is applied, and wherein said dielectric layer has openings to allow the application of metal contacts.

63. (Previously Presented) A photo-detector according to claim 61 to which a dielectric layer is applied to the surfaces of each mesa structure exposed by the etch treatment, and wherein said dielectric layer has openings to allow the application of metal contacts.

64. (Previously Presented) A photo-detector according to claim 50, wherein one or more mesa structures are etched through the uppermost layer to a depth suitable for electrical isolation.

65. (Previously Presented) A photo-detector according to claim 64 in which the surfaces of each mesa structure exposed by the etch treatment undergo a chemical treatment after which a dielectric layer is applied, and wherein said dielectric layer has openings to allow the application of metal contacts.

66. (Previously Presented) A photo-detector according to claim 64 to which a dielectric layer is applied to the surfaces of each mesa structure exposed by the etch treatment, and wherein said dielectric layer has openings to allow the application of metal contacts.

67.(Previously Presented) A photo-detector according to claim 33 in which the n-type doping in the barrier is concentrated in a very narrow delta doping layer located at the junction with the photon absorbing layer.

68. (Currently Amended) A photo-detector according to claim 67 wherein the n-type δ–doping layer has ~~typically~~ $5\times10^{10} < n < 10^{12}$ donors cm^{-2}.

69. (Previously Presented) A photo-detector according to claim 50 in which the p-type doping in the barrier is concentrated in a very narrow delta doping layer located at the junction with the photon absorbing layer.

70. (Currently Amended) A photo-detector according to claim 69 wherein the p-type δ–doping layer has ~~typically~~ $5\times10^{10} < p < 10^{12}$ acceptors cm^{-2}.

71. (New) A photo-detector according to claim 33, wherein the layer materials are selected such that when biased with an externally applied voltage, the bands in the photon absorbing layer next to the barrier layer are flat or accumulated, such that a depletion region exists only in the barrier and contact layers but not in the photon absorbing layer and a valence band edge in any part of the photon absorbing layer lies below a valence band edge in any part of the contact layer and does not lie more than $10kT_{op}$ above the valence band edge in any part of the barrier layer, where k is the Boltzman constant and T_{op} is the operating temperature.

72. (New) A photo-detector according to claim 50 wherein said layer materials are selected such that the middle barrier layer has an energy bandgap at least twice said energy bandgap of the photon absorbing layer, and wherein under flat band conditions a conduction

band edge of the contact layer lies above its own valence band edge or above a valence band edge of the barrier layer, by at least twice the bandgap energy of the photon absorbing layer.

73.(New) A photo-detector according to claim 50, wherein the layer materials are selected such that when biased with an externally applied voltage, the bands in the photon absorbing layer next to the barrier layer are flat or accumulated, such that a depletion region exists only in the barrier and contact layers but not in the photon absorbing layer, and a conduction band edge in any part of the photon absorbing layer lies above a conduction band edge in any part of the contact layer and does not lie more than $10kT_{op}$ below the conduction band edge in any part of the barrier layer, where k is the Boltzman constant and T_{op} is the operating temperature.